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ORIGINAL RESEARCH.

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THE GOVERNING PRINCIPLES
OF THE
ELEMENTS.

EXPLAINING AND SUPPLEMENTING
DR. DALTON'S DOCTRINE OF DEFINITE,
RECIPROCAL, AND MULTIPLE PROPORTIONS;
AND THE
SUBSTITUTION, HYDROGEN-REPLACEMENT,
AND COMPOUND RADICAL THEORIES
OF
MODERN CHEMISTRY,

BY

HERBERT MASSON.

LONDON:
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PREFACE.

In the early part of the present century, Dr. John Dalton, of Manchester, made known to the world his celebrated doctrine of Definite, Reciprocal, and Multiple Proportions. No scientific discovery of ancient or modern times, has had such important material results, or conferred so many benefits upon mankind; our own country, especially, having benefitted by it in the highest degree.

By the practical development of this doctrine, chemistry has advanced the Arts and Sciences, expanded the scope, and increased the products of our manufactures; opened out new sources of industry in every direction; extended trade and commerce; and thus, consequently, it has not only bestowed innumerable advantages, by promoting the prosperity, and increasing the wealth of individuals, but it has also conduced, in a remarkable degree, to the general and collective prosperity of the nation.

It has been the opinion of many eminent men of science, that—apart from the mere intellectual point of view—the extension of knowledge that would be acquired by the discovery of the fundamental principles which govern chemical combination, and those subordinate laws "which limit its generality in particular cases, which diminish the number of combinations abstractly possible, and restrain the indiscriminate mixture of elements" would, no doubt, be of the highest importance. Not only in giving a fundamental basis to the science, but by enabling chemists to combine theory with practice, prove an important aid to practical chemistry.

Dr. Dalton, in enunciating his theories, could not explain the secret and hidden governing principles which *compel* atomic-matter, when placed under the necessary conditions, to combine in definite proportions by weight, or, in a certain ratio of multiple proportions. Nor when we consider the subject closely, can we wonder that such should be the case, for we perceive how impossible it is for an intellect, however gigantic its power of conception may be, to descend from the grasp of a general and universal law of nature to its physical cause, and the immediate governing principles arising from the operation of that cause, which gives to the resulting phenomena its periodicity of recurrence and its universal generality. The very immensity of the subject forbids that it should come perfect from the hands of the discoverer.

It is only when a science has considerably advanced, when, by observation and experiment, a certain amount of correct data has been obtained—not by one person, but by numerous individuals, each contributing the result of their individual experience, and thus adding to the store of knowledge accumulating upon the subject—that it is possible, to descend from an universal law, to its particular or governing laws. For, the mind can only then conceive an idea of the originating cause, which, primarily, produces the known general phenomena.

In the following pages the reader will find a complete solution of the subject. As he reads page after page, he will find the "tangled-web unfold itself." By the new light thus afforded him, what before appeared vague, incongruous, dark, and apparently without definite plan, or regulation, will shine out in splendour, order, and beauty.

Investigation and research, have enabled the author, in the enunciation of these governing principles, to at once explain, and build up from the fundamental cause, to the general known laws of Chemistry.

In the progression, the reader will find the explanations lucid and clear, and in the evidence adduced in the numerical formula, the Chemist will instantly recognise the true explanation of the phenomena so familiar to him, and at once perceive, that the problem of chemical combination is solved.

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GENERALIZATION OF THE ELEMENTS.

Hydrogen is the lightest element known, its atomic weight being one, and it is used as the unit in chemistry. All the separate atoms of the simple elements are condensations of hydrogen units, which, in their aggregation, have left out of equilibrium with the rest of the atom, either one, two, three, four, five, six, or seven, constituent-units, each of which are of the value of one free hydrogen-unit. The elements taking up, or combining, under certain conditions, with other elements in the same proportions.

But with the free elements, or, in inorganic chemistry, the capacity for combination of the simple elements, are principally governed by one remarkable law, and it is to this law that I first call attention. Premising, that in the formula employed in this generalisation, all elements above the combining value of two units, will be expressed by figures. For instance in the phosphorus, arsenic, and antimony type, each of these elements have, in their arrangement, five constituent-units not in equilibrium, and are expressed by the number 5.

Now, from the effects of a physical cause, that will be shown, and fully explained presently, each atom of these elements will take up, or combine with three hydrogen atoms, and no more, to make up and complete the figure 8.

I here draw particular attention to the figures 4, 8, 16, and 32, also the modifications, 6, and 12, in connection with atoms and their replaceable hydrogen; for we shall see presently that to the attainment of these ruling numbers, forms the very essence of the principle of combination in inorganic chemistry.

The former numbers will be exclusively dealt with, in this, the first part of our generalisation,

Whatever is short of the figure 8 is filled up by replaceable hydrogen or other monads. For instance, in our graphic numerical formula :—

Examples	CH_4 ...	SiH_4 ...	PH_3 ...	AsH_3 ...	SbH_3
Becomes	$4\equiv H_4$..	$4\equiv H_4$..	$5\equiv H_3$..	$5\equiv H_3$..	$5\equiv H_3$
Ruling numbers ...	8	8	8	8	8

SH_2 ..	SeH_2 ..	ClH ..	BrH ..	IH
$6=H_2$..	$6=H_2$..	$7-H$..	$7-H$ ..	$7-H$
8	8	8	8	8

or, by transposition, in relation to the figures.

7	becomes	1	and acts	as a	Monad.
6	„	2	„	„	Diad.
5	„	3	„	„	Triad.
4	„	4	„	„	Tetrad.

Now, these subordinate hydrogen atoms, a few examples of which are given above, can separately, or collectively be replaced, that is, other elements can be substituted for them in the proper unit-proportion, or, distinct, but not complete molecules, which are termed compound radicals, can take their place, to complete *their* proper numbers, and in this case, each radical is reckoned the one into the other.

The elements, in inorganic chemistry, although subject in their combinations with each other, to these governing numerical laws, possess a distinct individuality, arising from the peculiar arrangement of their constituent-units, which gives rise to various minor subordinate laws, which will be fully explained when treating of the different elements.

There is one element and its combinations, that, in the first instance, will serve to explain lucidly, the governing principles, and, consequently, the subordinate laws of inorganic chemistry; the element to which I allude is Sulphur.

The atomic weight of a Sulphur-atom, considered as a whole, or in its entirety, has nothing whatever to do with its amount of attraction, or combination with other elements. It is collectively built up of 32 constituent-units, condensed and aggregated together, permanently united, indestructible, and incapable of sub-division under the conditions of Nature that surrounds us.

Each of these constituent-units have an inherent, and proportionate attraction for each other, and it is the arrangement, or distribution of these units into *groups*, whereby, some of them are left out of equilibrium, by certain parts of the atom not being equalised; giving rise to an influence which *compels* atom to unite with atom, and which we term chemical attraction, or affinity. This simple physical producing cause, gives birth to a fundamental principle, which, confers a certain capacity of combination to each element, and, while strictly defining the limit of capacity, admits of that capacity being varied, and modified, according to the conditions under which the combinations take place.

How, or under what conditions these units have aggregated, or were originally united, to form the compound atoms we term the simple elements, is an abstract question, which, at the present moment, is neither the subject, nor the object of our inquiry.

This generalisation explains only the governing principles of chemistry as exhibited in the phenomena and the reactions of the elements at the present time; the phenomena of yesterday and of to-day.

These principles not being the result of shadowy and vague speculations, but having for their verification, and in evidence of their truth, in every case, the test of numbers; these numbers have been deduced from experimental facts acquired in the science, not by one, but by countless individuals.

The principles, as shown in the following numerical equations, are, in their first rudiments, of so simple a nature, so striking in the beauty of the arrangement, and the symmetry of the numbers, and yet so competent to produce the most complex combinations, that the mere perusal of the equations will imprint the principles here enunciated indelibly upon the mind.

The reader must also bear in mind, these principles take nothing away from what has been already gained in the science, but only extends our knowledge. For instance, the reader after going through the Sulphur compounds, will know the *reason*, the *why*, these combinations are formed; will have seen the cause, and the sufficiency of that cause to produce the effects; and the single letter S will represent to his mind, not only the atomic weight and the equivalence of the element, but also the governing principles which subjects its own subordinates, and rules its relations with other compounds.

HYDROGEN-RELATIONS,

AND THE

FORMATION OF OXIDES, ACIDS, AND SALTS.

The governing principles regulating the chemical combination of Sulphur with Hydrogen, and the formation of Sulphides.

SULPHUR.

Atomic weight 32. Equivalence 2, 4, and 6. Atomicity, or hydrogen replacement, 2.

Numerical Formula 6.

Arrangement of the constituent-units in the Sulphur atom—

$$\boxed{\begin{array}{c}\text{Nucleus.}\\ \begin{array}{c}4\\4\end{array}\,18\,\begin{array}{c}2\\4\end{array}\end{array}}$$

We see here, in this constituent-formula, that there are 8 units upon the left of the nucleus, and 6 units upon the right, consequently, there is a deficiency of two units on this side.

The two required to attain the ruling-number 8, is supplied by combining with two hydrogen-units, thus—

$$\boxed{\begin{matrix}4\\4\end{matrix}\,18\,\begin{matrix}2\\4\end{matrix}}\begin{matrix}-H\\-H\end{matrix}$$

one, or both of which are replaceable.

We will now replace one atom of the hydrogen by a monad K, atomic weight 39 (using the figures on the right of the constituent-formula only, to save space), thus—

$$\underset{8}{\boxed{\begin{matrix}2\\4\end{matrix}}}\begin{matrix}-K\\-H\end{matrix}$$

It is now hydrogen potassium sulphide. Or, by replacing the two atoms of hydrogen by K_2, thus—

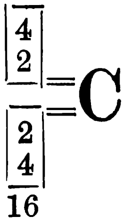
$$\underset{8}{\boxed{\begin{matrix}2\\4\end{matrix}}}\begin{matrix}-K\\-K\end{matrix}$$

forming potassium sulphide. Or, by replacing the H_2 by another element of two-unit combining value, namely, Calcium, atomic weight 40, thus—

$$\underset{8}{\boxed{\begin{matrix}2\\4\end{matrix}}}=Ca$$

it is now sulphide of Calcium.

Again, with Carbon, atomic weight 12, combining value four, we take two of sulphur, reversing one atom, thus— forming di-sulphide of carbon.



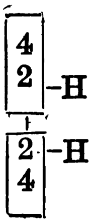
In short, the formation of compound molecules does not depend upon the relative atomic weight, but on the equalization and equilibrium of the constituent-unit attractions.

The left hand of the sulphur atom has another mode of action, and that is, when any subordinate atom attaches itself to the left, the amount of unit-attraction thus used, is deducted from the opposite side.

The entire principle of the atom will be fully explained after the phosphorus compounds.

Sulphur combines with hydrogen in two degrees, viz., SH_2, and S_2H_2. The last combination is an important modification of the former one, and is a simple illustration of the characteristic feature predominant in organic compounds.

The two atoms are bound together by one constituent-unit of each, thus— and in their *immediate*



relations, are always reckoned the ono into the other; while the amount thus substracted, is always deducted from the original combining number, and consequently, there are a corresponding number deficient in the amount of subordinate atoms they take up, or combine with.

In order to make the formulas clear and distinct, and not appear crowded, the figures will be printed in large type wherever necessary.

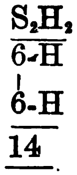
Examples of Sulphides, (the figure 6 represents sulphur).

$S\,Ca$	$S\,Na_2$	$S.Ba$	$S\,Zn$
$6^{=Ca}$	$6^{=Na_2}$	$6^{=Ba}$	$6^{=Zn}$
8	8	8	8

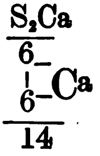
&c.

In all cases, the sulphur atom being perfectly indifferent to the atomic weight of the subordinate atoms taken up, and only susceptible to the combining-unit value.

The modification—

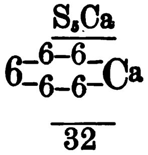


$$\begin{array}{l} S_2H_2 \\ \hline 6\text{-}H \\ | \\ 6\text{-}H \\ \hline 14 \end{array}$$



$$\begin{array}{l} S_2Ca \\ \hline 6\_ \\ |\;\;\;\;\;Ca \\ 6- \\ \hline 14 \end{array}$$

extends to



$$\begin{array}{c} S_5Ca \\ \hline 6{-6-6-\atop -6-6-}Ca \\ \hline 32 \end{array}$$

Or, the five figure six's, representing the constituent-units not in equilibrium in the sulphur atoms, amount collectively to 30, and require two more to complete their proper number, which is supplied by other elements; and the molecule reaches its limit, when the united figures and subordinates amount to the ruling number of 32; this number being four times that of the lowest sulphide.

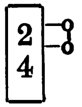
A remarkable illustration of this law is seen in the compounds of Potassium with Sulphur, which run in a continuous series, thus—

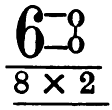
$$\frac{6{=}K_2}{8} \qquad \frac{\begin{array}{l}6\text{-}\\ \vdots\\ 6\text{-}\end{array}K_2}{14} \qquad \frac{6^{-6-}_{-6-}K_2}{20}$$

$$\frac{\begin{array}{l}6\text{-}6\text{-}\\ \vdots\\ 6\text{-}6\text{-}\end{array}K_2}{26} \qquad \text{and} \qquad \frac{6^{-6-6-}_{-6-6-}K_2}{32}$$

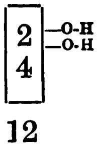
All sulphides are formed in obedience to the above remarkable laws; but, as we perceive in the constituent formula, there are four units latent in each sulphur-atom; these require also to be employed, and we shall now proceed to show the manner in which this is accomplished.

SULPHUR WITH OXYGEN AND HYDROGEN.

Sulphur takes up two atoms of oxygen to form its first oxide SO_2, thus, 

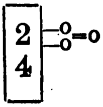
or graphically 

We have 8, and 2 attractions over, the two superfluous oxygen-units closing together. Now these two extra units require to be joined to two more to complete the number four.

This deficiency is supplied in two ways, either by H_2, thus— 

the oxygen-units enclosing and taking up H_2, one or both of which are capable of replacement, forming hydrosulphurous acid; or, as in the next stage,

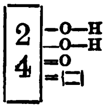
SO_3

by an atom of O, thus— 

The oxides are now complete, but in the formation of these oxides the unit-attractions of the sulphur-atom are not equalised, for while there are 8 unit-attractions engaged at the upper portion, the four units still remain latent at the lower portion of the atom.

In each of the above oxides the sulphur-atom proceeds to equalise itself with its subordinates, thus—

$SO_2 \times H_2O$

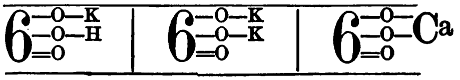


14

Two are latent.

The two extra oxygen-units having unclosed, and taken up H_2, while the liberated oxygen atom engages two of the latent units, forming sulphurous acid; one, or both, of the hydrogen atoms being replaceable by metals, and forming salts called sulphites. Examples—

$SO_3\,KH$ | $SO_3\,K_2$ | $SO_3\,Ca$



&c.

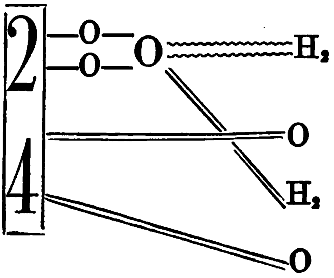
14 14 14

Two units of the sulphur atom, remaining latent throughout all the compounds.

In the next stage, SO_3 takes up the elements of a molecule of water, although $2H_2O$ are really engaged in the reaction

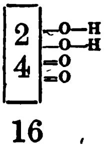
Dynamic

Equation



The outermost subordinate atom of oxygen being released, and combining with H_2 from one molecule of water, to again form H_2O; the H_2 from the other molecule of water taking its place, while the two liberated oxygen atoms unite with the four latent units.

SO_4H_2

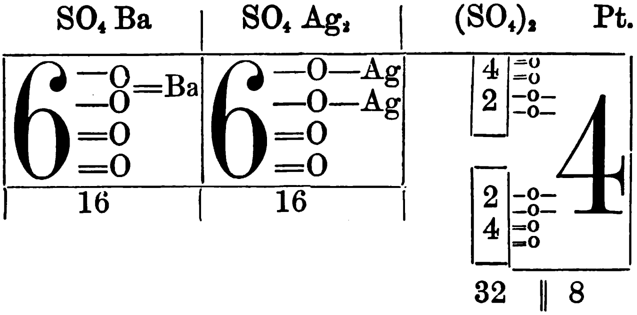


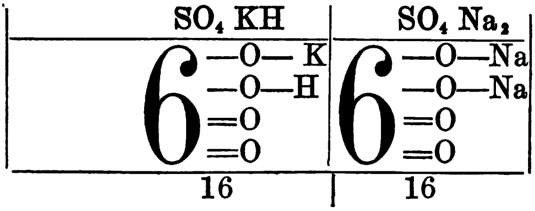
Forming the important compound, Sulphuric acid, one, or both Hydrogen atoms being replaceable, and forming salts, called Sulphates.

The growth of the molecule now ceases, its ruling number, 16 having been attained, it has reached its limitation, and therefore, its completion; for the unit attractions of the sulphur atom and its subordinates are equalised, and in equilibrium.

(*For the hydrates of the compound, see Oxygen.*)

Examples of Sulphates:—





$$\begin{array}{c|c} SO_4\,KH & SO_4\,Na_2 \\ \hline 6\begin{matrix}-O-K\\-O-H\\=O\\=O\end{matrix} & 6\begin{matrix}-O-Na\\-O-Na\\=O\\=O\end{matrix} \\ \hline 16 & 16\end{array}$$ &c.

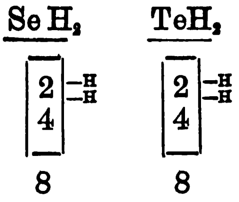
The modification S_2H_2, and the continuation up to pentathionic acid $S_5O_6H_2$, will be reserved until after the consideration of the phosphorus type. This modification in the gradual progression to attain the ruling number necessary for its completion, unfolds to our view the most exquisite and beautiful laws, giving us a first glimpse of those wonderful and harmonious hidden numerical laws of Nature, which rule, and govern, the formation of the most complex chemical combinations.

Selenium.—Atomic weight 79.

Constituent Arrangement $\boxed{{}^{4}_{4}65^{2}_{4}}$ and

Tellurium.—Atomic weight 129.

Constituent Arrangement $\boxed{{}^{4}_{4}115^{2}_{4}}$



$$\begin{array}{cc} \underline{SeH_2} & \underline{TeH_2} \\ \boxed{\begin{matrix}2\\4\end{matrix}}\begin{matrix}-H\\-H\end{matrix} & \boxed{\begin{matrix}2\\4\end{matrix}}\begin{matrix}-H\\-H\end{matrix} \\ 8 & 8 \end{array}$$

The formation of the acids and salts, corresponds to the analogous sulphur compounds.

PHOSPHORUS.

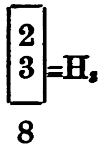
Atomic weight 31 Constituent Arrangement $\boxed{{}^{4}_{4}18^{2}_{3}}$ Graphically 5

The phosphorus atom is built up in precisely the same manner as the sulphur atom, with the exception that there is one unit less. This deficiency of one unit, has constituted phosphorus a different element, with entirely different properties, and a different mode of arrangement with its subordinates. No greater proof could possibly be given in evidence of the truth of these subordinate laws of the atomic theory, than is afforded by comparing the atomic weights of sulphur and phosphorus. For instance, the atomic weight of S is 32, while that of P is 31. Now, the deficiency of the one unit in the last element is made up by adding one more to its replaceable hydrogen to complete the number 8, thus—

$$\begin{array}{c} SH_2 \\ \hline 6\begin{smallmatrix}-H\\-H\end{smallmatrix} \\ \hline 8 \end{array} \qquad \begin{array}{c} PH_3 \\ \hline 5\begin{smallmatrix}-H\\-H\\-H\end{smallmatrix} \\ \hline 8 \end{array}$$

PHOSPHORUS AND HYDROGEN.

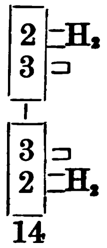
PH_3



Two are latent.

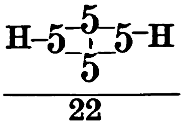
Modifications.

P_2H_4



Four are latent.

P_4H_2



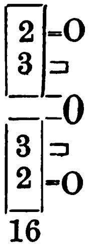
Eight are latent.

PHOSPHORUS WITH OXYGEN AND HYDROGEN.

Phosphorus forms two oxides, Phosphorus trioxide P_2O_3, and phosphorus pentoxide P_2O_5, thus:

First stage.

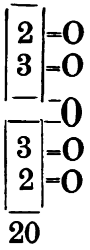
P_2O_3



Four are latent.

Second Stage.

P_2O_5

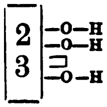


All employed.

P_2O_3 combines with three molecules of water, $3H_2O$.

and divides into two separate molecules, forming Phosphorous Acid, $2PO_3H_3$, thus—

Two



$$\begin{array}{c|l} 2 & -O-H \\ & -O-H \\ 3 & \sqsupset \\ & -O-H \end{array}$$

Two Hydrogen atoms being replaceable.

One H atom being replaceable,

14

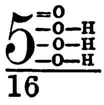
Two are latent.

giving rise to two classes of metallic phosphites.

We observe here, that the last molecule, PO_3H_3, has 12 units employed, and two units latent, making together the sum of 14. Now, our numerical governing law teaches us that it is not complete, and requires two more for its completion, and limitation. This deficiency is supplied at the next stage.

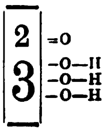
Phosphorus pentoxide, P_2O_5, combines with $3H_2O$, and divides into two complete and separate molecules, to form tribasic Phosphoric Acid, thus:

Two



$$\frac{5\begin{array}{l} =O \\ -O-H \\ -O-H \\ -O-H \end{array}}{16}$$

or, Two

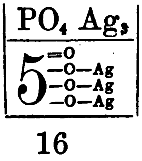


$$\begin{array}{c|l} 2 & =O \\ 3 & -O-H \\ & -O-H \\ & -O-H \end{array}$$

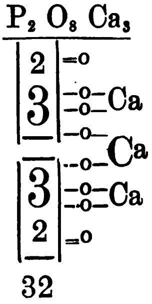
16

The three hydrogen atoms being replaceable by other elements.

This replacement, as in all other cases, being perfectly indifferent to weight, and only susceptible to the combining values of the elements substituted for them, forming a class of salts called Phosphates; thus, with silver, atomic weight 108:

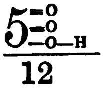


or with Calcium, atomic weight, 40:

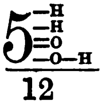


GRAPHIC NUMERICAL FORMULA OF THE ACIDS.

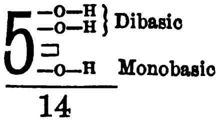
Metaphosphoric acid, $PO_3 H$
(Monobasic)



Hypophosphorus acid, $PO_2 H_3$
(Monobasic)



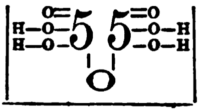
Phosphorous acid, $PO_3 H_3$.



Two are latent.

forming two classes of Phosphites.

Pyrophosphoric Acid, $P_2 O_7 H_4$. (Modification of $PO_4 H_3$.)



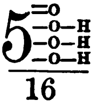
$$\begin{array}{|c|}\mathrm{H{-}O{-}}\overset{\mathrm{O=}}{5}\ \overset{\mathrm{=O}}{5}\mathrm{{-}O{-}H} \\ \mathrm{H{-}O{-}}\ \ \ \ \ \ \ \mathrm{{-}O{-}H} \\ \mathrm{O}\end{array}$$

28

The Hydrogen being replaceable, either all, or in part, by metals, forming salts called Pyrophosphates, thus—

($P_2\,O_7\,Na_4.$) ($P_2\,O_7\,Ag_4.$) ($P_2\,O_7\,Mg_2.$) ($P_2\,O_7\,H_2\,Na_2.$) &c.

Tribasic Phosphoric Acid, $PO_4\ H_3$.



$$5\begin{array}{l}=\mathrm{O}\\ -\mathrm{O}-\mathrm{H}\\ -\mathrm{O}-\mathrm{H}\\ -\mathrm{O}-\mathrm{H}\end{array}$$

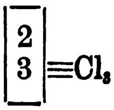
16

Attaining the ruling number, which decides the limitation.

PHOSPHORUS AND CHLORINE.

First Stage.

PCl_3



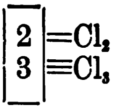
$$\left|\begin{array}{c}2\\3\end{array}\right|\equiv Cl_3$$

8

Two are latent.

Second Stage.

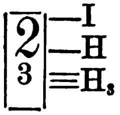
PCl_5



$$\left|\begin{array}{c}2\\3\end{array}\right|\begin{array}{l}=Cl_2\\ \equiv Cl_3\end{array}$$

10

$PH_4\ I$

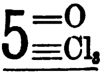


$$\left|\begin{array}{c}2\\3\end{array}\right|\begin{array}{l}-I\\ -H\\ \equiv H_3\end{array}$$

10

All employed.

Phosphorus Oxy-chloride, $PO\ Cl_3$

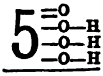


$$5\begin{array}{l}=O\\ \equiv Cl_3\end{array}$$

10

decomposed by water, $3H_2\ O$, and forming

$PO_4\ H_3$



$$5\begin{array}{l}=\mathrm{O}\\ -\mathrm{O}-\mathrm{H}\\ -\mathrm{O}-\mathrm{H}\\ -\mathrm{O}-\mathrm{H}\end{array}$$

16

×

$3ClH$

7-H

8

Phosphorus also forms, with Bromine, corresponding compounds.

Arsenic.—Atomic weight, 75.

Constituent Arrangement

$$\boxed{\begin{array}{c}4\\4\end{array}62\begin{array}{c}2\\3\end{array}}$$

Graphically 5

AsH_3	$AsCl_3$	$AsBr_3$	AsI_3
$\begin{array}{\|c\|l}\hline 2 & \\ 3 & \equiv H_3 \\ \hline\end{array}$	$\begin{array}{\|c\|l}\hline 2 & \\ 3 & \equiv Cl_3 \\ \hline\end{array}$	$\begin{array}{\|c\|l}\hline 2 & \\ 3 & \equiv Br_3 \\ \hline\end{array}$	$\begin{array}{\|c\|l}\hline 2 & \\ 3 & \equiv I_3 \\ \hline\end{array}$
8	8	8	8

Two are latent in each.

OXIDES.

As_2O_3	As_2O_5
$\begin{array}{\|c\|l}\hline 2 & \sqsupset \\ 3 & =O \\ \hline & -O \\ \hline 3 & =O \\ 2 & \sqsupset \\ \hline\end{array}$	$\begin{array}{cl} & =O \\ 5 & =O \\ & -O \\ 5 & =O \\ & =O \end{array}$
16	20
Four are latent.	All employed.

forming arsenates, resembling in construction the corresponding Tribasic Phosphates.

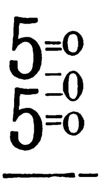
Antimony.—Atomic weight, 122.

Constituent Arrangement $\left|\begin{smallmatrix}4\\4\end{smallmatrix}109\begin{smallmatrix}2\\3\end{smallmatrix}\right|$ Graphically 5

SbH_3	$SbCl_3$	$SbCl_5$
$\begin{array}{\|c\|l}\hline 2 & \\ 3 & \equiv H_3 \\ \hline\end{array}$	$\begin{array}{\|c\|l}\hline 2 & \\ 3 & \equiv Cl_3 \\ \hline\end{array}$	$\begin{array}{\|c\|l}\hline 2 & =Cl_2 \\ 3 & \equiv Cl_3 \\ \hline\end{array}$
8	8	10
Two are latent.	Two are latent.	

OXIDES.

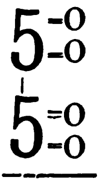
$Sb_2\,O_3$



16

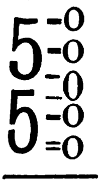
Four are latent.

$Sb_2\,O_4$



18

$Sb_2\,O_5$



20

All employed.

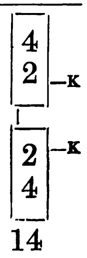
The acids are similar in construction to the Phosphorus acids.

SULPHUR COMPOUNDS

Continued.

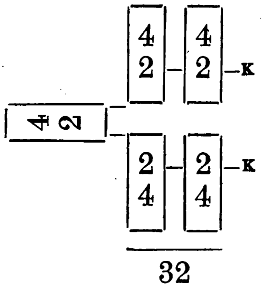
HYDROGEN Disulphide $S_2 H_2$, and the continuation of this modification up to its limitation, Pentathionic acid, $S_5 O_6 H_2$, is of the highest interest, as it affords us an insight into the laws which rule the formation of complex molecules, and, in the gradual progression, step by step, to attain the ruling number necessary to form the completion of this series of compounds, exhibits the mode by which that ruling number is attained; and, as these laws enter largely into the Carbon-compounds, it is important they should be understood.

Remembering, that when two, or more, of a simple element are bound together, they are reckoned the one into the other in their immediate relationship, and, that the amount thus used, is always deducted from the original value, thus— $S_2 K_2$



There is in this example, 6 units active, and 8 units latent, amounting altogether to the sum of 14.

Now, it is absolutely necessary, that the active and latent units in this class of sulphides, for the limitation, and therefore the completion of the series of compounds, should attain a ruling number. This, $S_2 K_2$ proceeds to do progressively, by adding Sulphur-atoms to the left of the molecule, until the amount of units, active and latent, reaches the ruling number 32, forming $S_5 K_2$.



12 active
20 latent
32

We see in the above formula there are 20 units latent; these are employed in the formation of a series of oxides, which, however, are only known in their combinations.

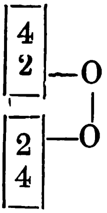
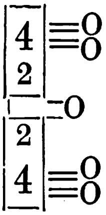
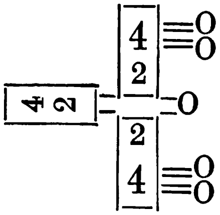
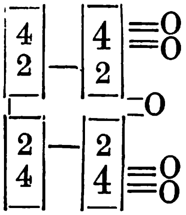
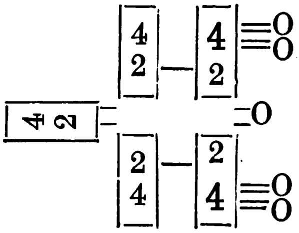
DEVELOPMENT OF THE GOVERNING

OXIDES.

(DEDUCED FROM THEIR SALTS.)

OXY-ACIDS OF

(Ruling Numbe

$S_2 O_2$		Each of these oxides in union with the elements of a molecule of water $H_2 O$, (whether directly or indirectly obtained) become the corresponding acids.	Hy
$S_2 O_5$			Di
$S_3 O_5$			Tr
$S_4 O_5$	 4 2 4 2 O O O 2 4 2 4 O O		Te
$S_5 O_5$	 4 2 4 2 O O 4 2 O 2 4 2 4 O O		Pe

{ C

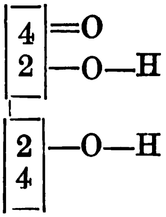
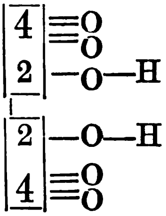
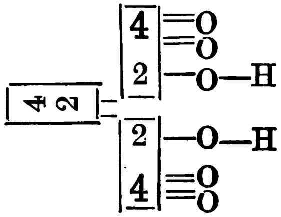
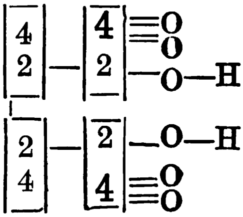
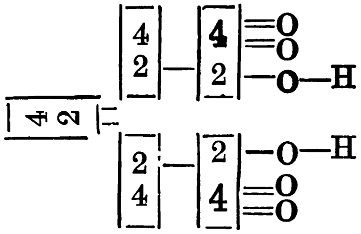
INCIPLE IN MULTIPLE PROPORTIONS.

PHUR (*Continued*).

2 active units.)

ACIDS.

(THE HYDROGEN REPLACEABLE.)

lphurous Acid.	$S_2O_3H_2$	
ic Acid.	$S_2O_6H_2$	
nic Acid.	$S_3O_6H_2$	
hionic Acid.	$S_4O_6H_2$	
hionic Acid.	$S_5O_6H_2$	

Oxygen units active 12.
sponding Molecular latency 12.

32 units active.

The preceding diagram explains the formation of the oxides and their corresponding acids.

In Sulphuric acid, the one Sulphur-atom was the governing atom, that gathered its subordinates to complete its ruling number. In Pentathionic acid there are five necessary, and for the 12 units of O employed, there are 12 latent units at a distant part of the molecule.

The principle of molecular latency enters largely into the formation of complex compounds.

THE GENERAL PRINCIPLE OF THE ATOMS.

An atom consists of an aggregation of constituent-units, each of which is of the value of one free Hydrogen atom. These constituent-units, moreover, are bound together in groups of two, three, and four, and it is in the difference between the two exterior and opposite rows of units, which gives the amount of capacity of combination to the element. The middle portion, in the higher Atomic weights, consisting of a nucleus, containing a different amount of units in different elements, the difference not interfering with the general principle. Thus, as we have seen in the elements P, As, and Sb, the nucleus in each are different, for they contain a dissimilar amount of units, while the exterior portions are precisely similar, and their combinations have a corresponding similitude. This type can be expressed by $8\big|\genfrac{}{}{0pt}{}{2}{3}$. The attractions of the two-units, in the group 2 neutralising each other, and those of the group 3, being associated and neutralising each other. Now, we can employ the group 3 and leave the 2 latent, or, employ the group 2 and one of the group 3, or one of the group 3 leaving 4 latent, or employ all the five, but, in no case can four be engaged and one left unemployed, for a single unit cannot exist by itself. For instance, in PCl_3, the lower group is employed $\left|\begin{array}{c}2\\3\end{array}\right|\begin{array}{l}\\ \equiv Cl_3,\end{array}$ while in PCl_5, the two groups are used, $\left|\begin{array}{c}2\\3\end{array}\right|\begin{array}{l}=Cl_2\\ \equiv Cl_3\end{array}$ But in no case can we have

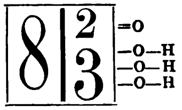
$$\left|\begin{array}{c}2\\3\end{array}\right|\begin{array}{l}-\\ \equiv\end{array}Cl_4 \qquad \text{or} \qquad \left|\begin{array}{c}2\\3\end{array}\right|\begin{array}{l}\\ =Cl_2\end{array}$$

in a single molecule, because then there would be one unit left unemployed in each of the groups.

Again, in the Oxides, it is impossible that there should be $\left|\begin{array}{c}2\\3\end{array}\right|\begin{array}{l}\\ =O\end{array}$ or $\left|\begin{array}{c}2\\3\end{array}\right|\begin{array}{l}=O\\ =O\end{array}$ so we see the absolute necessity of two atoms of P being employed.

(*See Oxides and Acids, page* 24.)

When P forms its acids, the Hydrogen is *deferred*, stage by stage, until the ruling number is reached, and represents the deficiency upon the right of the atom, while the complete amount of Oxygen taken up, represents the figure 8 on the left, thus—



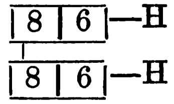
16 units
actively engaged.

And, as there are only five units of the P atom with which the O atoms can directly unite themselves, the Hydrogen must necessarily be deferred, to complete the ruling number.

We have here the true explanation of the employment of a compound radical that has played a conspicuous part in modern chemistry, namely Hydroxyl 'OH. We see that this radical, wherever it is found in any compound, whether directly or indirectly formed, or simply transferred, is merely subordinate, and is acting in strict obedience to an absolute numerical principle, The H being replaceable by other elements of, or, amounting to the same combining value. The molecules being perfectly indifferent, in all cases, to the atomic weight of the subordinates thus taken in exchange, and only susceptible to the numerical ratio : for, the elements can only combine numerically, and the Combining Proportions are, what Dr. Dalton conceived, and expressed them to be, namely, the relative atomic weight of the elements. The extraordinary combining property of Oxygen, as we see it exhibited in the acids, depends upon its peculiar atomic construction, a full explanation of which will be given in the chapter on Oxygen. The arrangement of the constituent-units in all the elements of small atomic weight will be shown in full.

We will now enter into the consideration of the figure 8| upon the left of the atom.

These units must always remain directly or indirectly perfect. In the above combinations they remain perfect, because only the right of the atom was used; but the case is different when a modification occurs, whereby one, or more, of these units are employed. Thus, in

$S_2 H_2$ 

the two units used *between* the Sulphur-atoms being deducted, leaves 7 each. Now these sevens require one each to complete their number 8. This is accomplished by uniting *indirectly*, or neutralising, two of the units upon the opposite side; so that not only must these units be deducted from the right, but also, the subordinates those units would have taken up, if no modification had occurred.

But, so perfect is the mathematical principle upon which the combination of the elements is founded, that the series will run up to a multiple of the ruling number for their completion. A beautiful, yet comparatively simple, example has been shown in the Sulphur compounds; the more striking examples will be seen in the Carbon compounds. In the equivalent relations of the

S atom, if we deduct 2 or 4 from the left, exactly the same amount will be neutralized upon the opposite side. Although these principles are general, still, each element possesses an individuality, arising from its construction, which shows itself by some peculiar combinations pertaining to that particular element alone; these will be treated in their proper place.

COMPOUND RADICALS.

(INORGANIC.)

WHENEVER combinations are short of their ruling numbers, they become Compound Radicals.

Examples—short of the number 8.

'SH	'PH_2	''PH	'$As\,H_2$	'$Sb\,H_2$	
'6—H	'5=H_2	''5—H	'5=H_2	'5=H_2	&c.
7	7	6	7	7	

or, when they are short of any of the deferred H in the acids. Also when they are short of the representative figure of the element, as thus, with Phosphorus,

'PH_4
'5≣H_4
9

When compound radicals attach themselves to other incomplete molecules, they are always to be reckoned, in their immediate relationship, the one into the other, to complete their respective numbers.

(See following chapters on Carbon and Nitrogen.)

RECIPROCAL LATENCY.

Chemists have long observed the similitude in the combining capacities of Sulphur and Oxygen, especially as exhibited in the Oxy-and Sulpho-acids.

This resemblance is displayed in a remarkable manner in the compounds of P, As, and Sb, with Sulphur.

The following diagram explains *why* this is the case, and shows the formation of a large class of compounds, at the same time introducing a new class of numerical phenomena, Reciprocal Latency.

(See diagram on following page.)

ISOMERISM, &c.

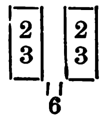
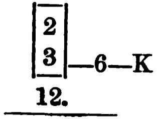
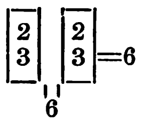
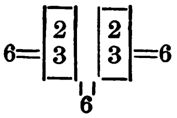
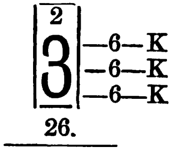
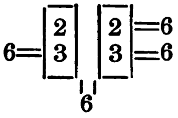
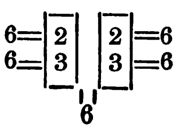
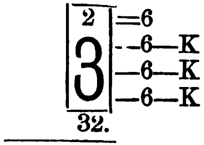
The subordinates are not always attached in precisely the same manner to the ruling element. When a difference of attachment occurs, although exactly the same elements are present in the molecules, still, there is a difference of properties and substance. In the SO_3 dealt with in a preceding chapter, that particular arrangement of the S with its subordinates has given birth to *Melecular laws*, whereby, the *molecules* of the SO_3 have united among themselves to form a definite structure, dependent for its origin, in the first instance, to *chemical* arrangement, but, in the actual formation of the structure, upon entirely distinct and different principles, for they no longer obey

DEVELOPMENT OF THE GOVERNING PRINCIPLE IN MULTIPLE PROPORTIONS.

RECIPROCAL LATENCY.

FORMATION OF THE SALTS OF PHOSPHORUS AND SULPHUR.

PHOSPHIDES OF SULPHUR. SALTS. **Ruling Number 32.**

PHOSPHIDES OF SULPHUR.		SALTS.		
P_2S		PSK		8 are latent.
P_2S_2				
P_2S_3		PS_3K_3		14 are latent.
P_2S_4				
P_2S_5		PS_4K_3		16 active, and 16 latent. COMPLETE.

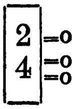
ARSENIC COMPOUNDS. Ruling Number 32.

	ACID.		ACID.
As_2S_3	AsS_3H_3	As_2S_5	AsS_4H_3

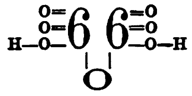
ANTIMONY COMPOUNDS. Ruling Number 32.

SIMILAR CONSTRUCTION.

the chemical numerical laws. For instance, the SO_3 treated of above, is a solid, and one of its silky crystals may contain countless millions of molecules of the SO_3, but the aggregation, or uniting together to form this structure, has not altered the qualities or properties of the compound, for we can destroy the structure by reducing it into fragments, and the smallest fragment contains the same qualities and properties as the whole compound before reduction.

In the isomer of the same compound, liquid sulphuric anhydride, SO_3  $\boxed{\begin{matrix}2\\4\end{matrix}}\begin{matrix}=O\\=O\\=O\end{matrix}$ although there are precisely the same elements concerned as in a molecule of the former compound, the properties and substance are different; the dissimilar attachment of the subordinates in the latter combination not giving rise to structural arrangement. Hence it is a liquid.

This last compound combines with $SO_4\,H_2$ to form a compound molecule, thus—



$$\begin{matrix} & O= & & & & =O & \\ & O= & 6 & & 6 & =O & \\ H- & O- & & & & -O & -H \\ & & | & & | & & \\ & & & O & & & \end{matrix}$$

28

The $SO_4\,H_2$ has reached its limitation, and therefore can do no more. In the liquid SO_3, the oxygen attached to the group 2 has opened out, and robbed the $SO_4\,H_2$ of one of its Hydrogen atoms, the O bridging over to the now not occupied unit, and thus binding the two molecules into one compound, and forming Pyrosulphuric acid (or, Nordhausen acid.) $S_2 O_7 H_2$.

This particular form of combination is of frequent occurrence, thus—

$P_2 O_7 H_4$ $As_2 O_7 Na_4$, $P_2 S_3 Br_4$ &c.

HALOGENS.

$$\left.\begin{array}{l}\textbf{Chlorine.}\text{—Atomic weight } 35\tfrac{1}{2}.\\ \textbf{Bromine.}\text{—Atomic weight } 80.\\ \textbf{Iodine.}\text{—Atomic weight } 127.\end{array}\right\}\begin{array}{c}\text{Constituent}\\ \text{Arrangement}\end{array}\ \boxed{\begin{array}{c}3\ \ 4\\ \hline \text{Nucleus}\\ \hline 8\end{array}}$$

The reader is referred to a subsequent chapter on Atomic Physics, for an explanation of the fractions contained in the element Chlorine. The subject is perfectly understood; but it would break the thread of our generalization, and therefore be inexpedient, to pursue the subject further at the present moment. Suffice it to say, there *are* fractions, and that those fractions reside in the nucleus; but they do not interfere with the general principle of the combinations.

CHLORINE.

Constituent Arrangement $8\,|\,^{3}_{4}$ Graphically 7.

$$\begin{array}{c}\text{Cl H}\\ \hline 7\text{–H}\\ \hline 8\end{array}\qquad\qquad \begin{array}{c}\text{Ca Cl}_2\\ \hline \left.\begin{array}{l}7–\\ 7–\end{array}\right.\text{Ca}\\ \hline 16\end{array}\qquad\qquad \begin{array}{c}\text{Cl Na}\\ \hline 7–7\\ \hline 14\end{array}$$

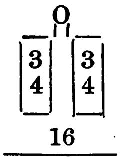
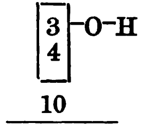
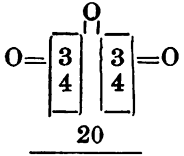
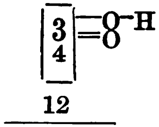
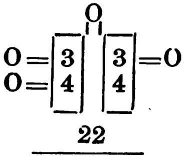
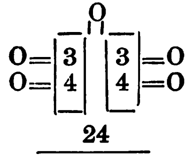
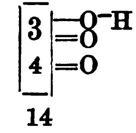
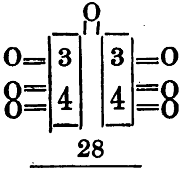
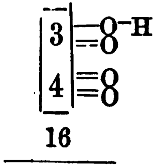
As Monads.

(*See diagram on following page.*)

DEVELOPMENT OF THE GOVERNING PRINCIPLE IN MULTIPLE PROPORTIONS.

FORMATION OF THE OXY-ACIDS OF CHLORINE.

Ruling Number 16.

OXIDES.			ACIDS.			
Cl_2O		12 are latent.	Hypochlorous ..	Cl O H.		6 are latent.
Cl_2O_3		8 are latent.	Chlorous	$Cl O_2 H.$		4 are latent.
Cl_2O_4		6 are latent.				
Not known. Cl_2O_5		4 are latent.	Chloric	$Cl O_3 H.$		2 are latent.
Cl_2O_7		All employed.	Perchloric	$Cl O_4 H.$		All employed. COMPLETE.

BROMINE AND IODINE.

Ruling Number, 16.

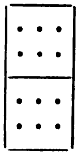
Constituent	Br H	IH
Arrangement	7–H	7–H
$8\,\vert^{3}_{4}$	8	8

The oxides and acids of these elements, are of similar construction to the corresponding Chlorine compounds.

It has been one of the mysteries of chemistry, *why*, Cl, Br, and I, being themselves Monads, should be fixed, and the Hydrogen only replaceable. Our numerical formula at once explains the mystery.

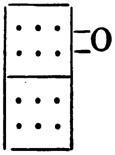
Carbon (Inorganic).—Atomic weight 12.

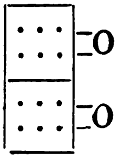
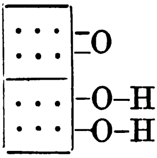
Constituent Arrangement



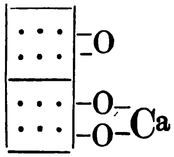
Graphically 4.

The Carbon atom consists of two groups, with six constituent-units in each group. When Carbon combines with Oxygen to form Carbonic oxide, CO, the Oxygen binds one side of the Carbon together, and brings it up to the number 8, thus—



leaving six units upon the other side. This part of the atom, then, acting in conjunction with the other part, similar to the right and left sides of the sulphur atom, CO_2 being thus—  and the corresponding acid, $CO_3\ H_2$ (only known in its salts), has the composition  the O_2 representing four of the constituent-units upon this side of the Carbon, and H_2 the other two.

$CO_2 \times Ca\ O$

Example of Salts— 

CARBON.

IN ITS ORGANIC RELATIONS.

Would'st learn my secrets?
Search. From East to West my reign is boundless;
And from the tall and stately palm, and wealth
Of verdure of the Southern sunny climes,
To the lowly moss on Iceland's Northern
Shores, all vegetation owns my sway.
Search. When the zephyrs of the early Spring
Have come, breathing new life in every sigh;
Awakening Nature from its wint'ry sleep,
And bestowing upon vegetation
A renewed existence; then, seek for me
In the tiny peeping-buds, just bursting
Into life on every tree and bush.

'Neath Summer skies,
My nest lies hid amongst the flowers, where a
Thousand beauteous forms and tints of colour,
Grace and adorn my floral fairy-home.
I give ambrosial nectar to the flowers,
The grateful fragrance to the perfumed rose,
The leafy verdure to the woods and groves;
And find a dwelling in each blade of grass,
That clothes the verdant fields with living green.

At Autumn-time,
Behold me in the fields of golden corn;
And taste me in the sweet delicious
Juices of the ripe and mellow fruit.
Or, go into my own domain—
The Forest. (From the lowly shrub to the
Majestic oak, all own me master there.)
And while the Evening-breeze flows through the forest-glades,
Waving my leafy banners gaily in the air,
Listen! and hear the music of the rustling leaves
Proclaiming my supremacy; acclaiming me
The Monarch, Lord, and Chief of all the Elements.

Not thus shall be my search, proud element;
But I will take one of thy wondrous forms,
One of thy grandest structures, and by the
Potent agency of Heat, I will command
Thy subordinates to fly from thee.—

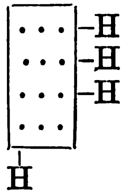
What art thou now? Poor element!—Black as
The shades of Night; the slightest touch will crush
Thee into powder, a mass devoid of
Colour, form, or beauty.—Disclose thyself.

CARBON—GOVERNING PRINCIPLES.

(Organic.)

FORMATION OF THE HYDRIDES, COMPOUND-RADICALS, ALCOHOLS, AND ACIDS, OF THE PRIMARY CARBON COMPOUNDS.

When Carbon combines with Hydrogen, either naturally, under organic influence, or artificially, when the necessary conditions are given by the agency, and through the reason and intelligence of man, the atoms of this element become endowed with the power of uniting together in a remarkable manner. The physical cause of this extraordinary capacity for combination, arises from this; that when Hydrogen combines with Carbon, the Carbon is divided into four groups, thus—



each division acting separately. This division, or Hydrogen influence, gives to Carbon the power of uniting atom to atom to attain a ruling number, and to form an immense *compound-element*, which I shall term Carbonium.

I will now give a graphic illustration of this compound-element; premising, that figures will only be used in the exposition, and explanation, of the governing principles.

Carbonium has two principal modes of action, precisely similar to the principle of the inorganic combinations, namely, a Carbide for its Hydrogen relation, and the full combination for its Acid relation, where the Hydrogen is deferred to complete the necessary number of units required to attain the ruling number for its completion, and limitation.

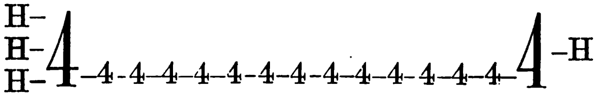
Carbon, in its numerical relations, observes the same combining principle as we have observed Sulphur to do in inorganic chemistry, for instance, in the construction of $S_5 H_2$ (the graphical number of S is six) if we place the atoms thus, by adding up from left to right, we have—

$$\begin{array}{ccccccccccccc} \mathrm{H} & — & 6 & — & 6 & — & 6 & — & 6 & — & 6 & — & \mathrm{H} \\ \hline 1 & & 7 & & 13 & & 19 & & 25 & & 31 & & 32 \end{array}$$

The Carbide of Carbonium is constructed in a similar manner, and is composed of 15 atoms of Carbon linked together, thus—

ILLUSTRATION,

Showing the governing principle of the carbide.



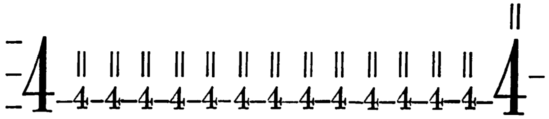
$$\left.\begin{array}{r}H-\\H-\\H-\end{array}\right.\!\mathbf{4}-4-4-4-4-4-4-4-4-4-4-4-4-4-\mathbf{4}-H$$

(The Carbon has 32 units actively employed.)

The fifteen figures added together are 60, and the four Hydrogen units added, complete the ruling number of 64, being a multiple of eight times that of marsh-gas, $C\,H_4\ \frac{4\equiv H_4}{8}$ the one atom of Hydrogen deficient from the left face of the illustration, being reproduced on the face upon the right, at the end of the chain.

ILLUSTRATION,

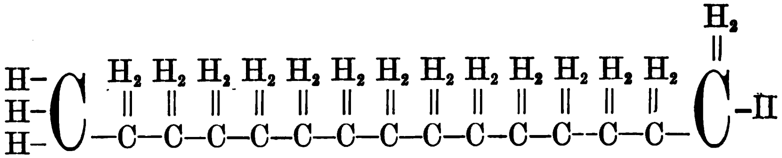
Showing the full active capacity of 32 units.



$$\left.\begin{array}{r}-\\-\\-\end{array}\right.\!\mathbf{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{4}-\overset{\|}{\mathbf{4}}-$$

ILLUSTRATION,

The Carbide complete, with its 32 Hydrogen subordinates.



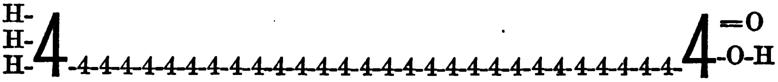
$$\left.\begin{array}{r}H-\\H-\\H-\end{array}\right.\!\mathbf{C}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{C}}-\overset{H_2}{\overset{\|}{\mathbf{C}}}-H$$

If this chain is divided, in any place whatever, each of the parts thus separated, become compound radicals, corresponding to the number of Carbon atoms each part may contain.

The compound-element Carbonium, is composed of 30 Carbon atoms, linked together thus—

ILLUSTRATION,

Showing the governing principle of Carbonium.



$$\begin{matrix}\mathrm{H}-\\\mathrm{H}-\\\mathrm{H}-\end{matrix}\mathbf{4}-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-\mathbf{4}\begin{matrix}=\mathrm{O}\\-\mathrm{O}-\mathrm{H}\end{matrix}$$

(The Carbon has 64 units actively employed.)

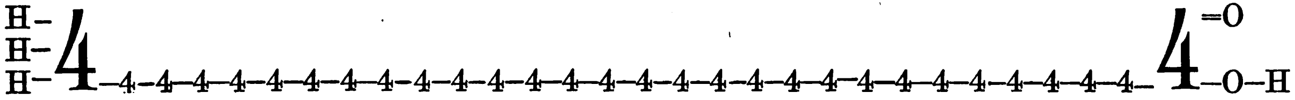
The 30 figures added together are 120, and the eight units of Oxygen and Hydrogen added, complete the ruling number of 128, being twice that of the carbide, and a multiple of 16 times that of marsh-gas; the one atom of Hydrogen deficient on the left face of the illustration, being reproduced, and deferred, on the face upon the right, at the end of the chain. *Why* this Hydrogen unit is deferred, and the *reason* of its being joined to an atom of Oxygen, will be seen in the following graphic picture.

(*See diagram.*)

In No. 2 on the diagram, we see there are only 62 direct unit capacities left unemployed which can take up subordinates, and the principle being imperative, that a ruling number must be attained for completion, it is accomplished by the union of one unit of an Oxygen

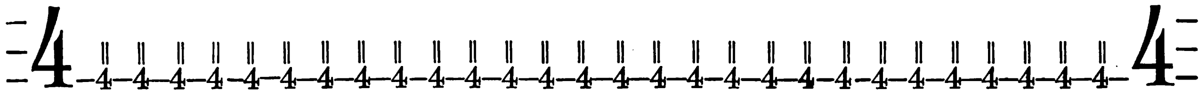
DEVELOPMENT OF THE GOVERNING PRINCIPLE IN MULTIPLE PROPORTIONS

THE CARBON COMPOUNDS.

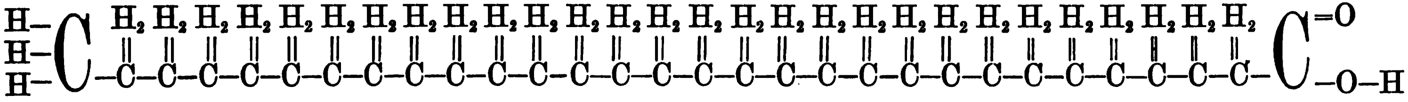


(The figures, with the eight units of the subordinates added, amount to **128**,)
64 units of the Carbon being employed.

Full *direct* combining capacity of **62** units.



Carbonium—With its full subordinates of **64** units.



Forming Melissic Acid.

atom direct with the Carbon, and the other unit of the Oxygen to the Hydrogen atom at the end of the chain, as shown in figure 3 in the diagram, where the ruling number of 64 is attained by the subordinates.

This wonderful combination advances, from its first stage in Methyl-hydride, to its completion, in the highest acid, progressively, step by step, every stage being a definite product. And in the substitution of other elements, or combination of elements in the place, or in exchange for its replaceable Hydrogen, proceeds, step by step, until the 30 atoms of Carbon are reached which forms its limitation, and which are now known by the term "homologous series."

Some of these homologous series we are acquainted with in their fulness, while in others, we have detached portions more or less complete; and some are only known in isolated fragments. But, the principle being universal, the formation of any portion of a series is not confined either to time or place, or to any one particular organized structure. One fragment exists in one species of plant, while another fragment of the same series, exists in a different species; the fragments may be separated as wide as the poles from each other; some may only have existed in the past geological ages of the world, while others may never yet have been formed. But the principle is universal, and absolute; wherever, and whenever, the elements are placed under the

ND—EIUM.

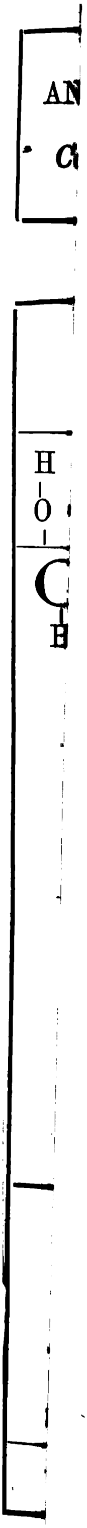
NS. (Prima

IPOUNI

ATOMS EMP

16	17	18	28	29	30
34	36	38	58	60	62
H	H	H	H	H	H
C H_2	C H_2	C H	C H_2	C H_2	C H_2

But the [illegible] and whenever, the elements are placed under the


AN
C
H
O
C
H

necessary conditions for combination, there will the compound be formed.

The following diagrams are the detached *links of the chain* in the preceding diagram, with the subordinates attached, each link being a definite product.

These diagrams give a complete key and solution to the primary Carbon compounds; the subordinates being so arranged, that their relations with the Carbon can be seen and understood, at once.

(See large diagrams.)

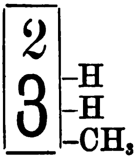
Each of the compound radicals, in the first of the preceding diagrams, acts as a monad element; because, when they combine, they then complete their respective hydride numbers (see the second row of figures in the diagram). These hydride numbers being the representative figures of the fragments of the compound-element of the series, in the same manner, and fulfilling similar functions to the representative figures used for the simple elements.

In combining with an element of higher equivalence, for instance Phosphorus, the Compound Radicals and the Phosphorus each obey their respective numerical laws; the Phosphorus being reckoned into the Radicals, and the *separate* Radicals being reckoned into the Phosphorus.

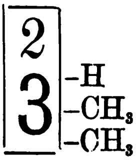
The following illustration will make this quite clear.

Other Radicals, or mixed Radicals, can be used instead of the Methyl, but, in all cases, this law remains absolute.

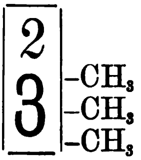
$PH_2\,CH_3$



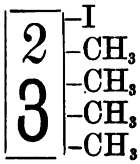
$PH\,(CH_3)_2$



$P\,(CH_3)_3$



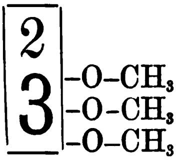
$PI\,(CH_3)_4$



Two latent in each. All employed.

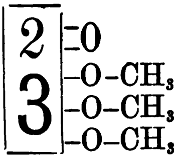
Successively, in a similar manner with the deferred radicals.

$PO_3\,Me_3$



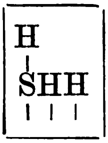
Two are latent.

$PO_4\,Me_3$



All employed.

Sulphur can replace the Oxygen in the Alcohols (see the preceding diagram,) thus—



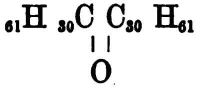
the S being subordinate in these combinations, but it cannot replace the O_2 in the acids; because of its tendency to become the ruling element, and to run into its own series of sulphides, (as shown at page 31.)

Examples :—Vinic Sulphide $S\,(C_2\,H_5)_2$

Vinic Disulphide $S_2\,(C_2\,H_5)_2$

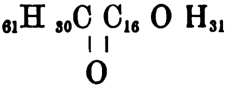
In these examples, the carbon radicals are the subordinates.

It will now have been seen, what that potent hidden agency is, which gives to carbon, above all the other elements, the peculiar power of uniting with itself; as we see it manifested in the carbon compounds. The fixity of the element being solely due to its especial numerical combining basis. The 30 atoms of carbon being the limitation of *direct* union, when compounds are found containing more carbon, the extra carbon atoms are united into the molecule by the interposition of some other element, as in Melisyl Ether,



$${}_{61}H\ \underset{\overset{\|}{O}}{{}_{30}C\ C_{30}}\ H_{61}$$

or, in Melisyl Palmitate,



$${}_{61}H\ \underset{\overset{\|}{O}}{{}_{30}C\ C_{16}}\ O\ H_{31}$$

&c.

By referring to $CO_3\,H_2$, at the beginning of this chapter, the reader will observe, that the oxygen atom attached entirely to the carbon, is differently placed to what it is in these compounds. The oxygen, in the carbon compounds, occupying the two inner units.

When the carbon again forms its CO, or CO_2, the carbon atom resets itself, as it were, again into its two natural groups, or divisions.

FIRST MODIFICATION.

Ethylene, $C_2 H_4$

THE combinations arising from this modification, may, at first sight, appear to act contrary to the principles herein enunciated, they having, apparently, two extra for completion; but to understand the combinations, and to ascertain, and become cognisant of the reason, the *why*, we must have recourse to our potent numerical formula.

ILLUSTRATION,

Showing the principle of the modification.

$$\begin{array}{l} {}_2H = \Large{4} - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 \\ \quad < \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad | \\ {}_2H = \Large{4} - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 \end{array}$$

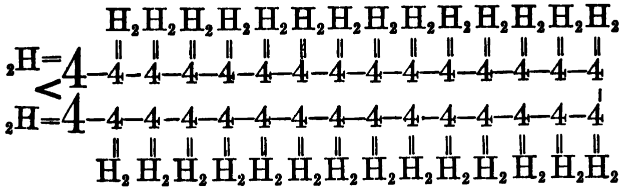
(64 units of the Carbon are employed.)

The 30 fours added together are 120, and the four hydrogen units added, make up the sum of 124; our figures telling us distinctly, that there are four short, as will be perceived in the next illustration.

ILLUSTRATION.

Full combining capacity of 60 units.

Melene.



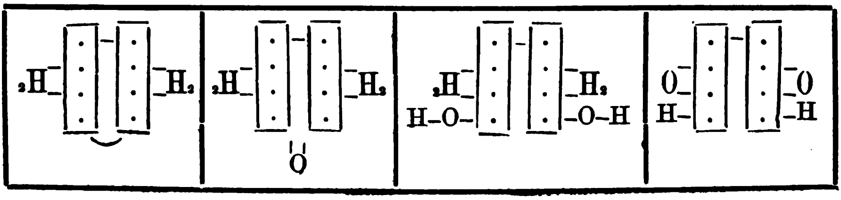
$$\begin{array}{l} \qquad\quad H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2 \\ {}_2H{=}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4 \\ \quad < \\ {}_2H{=}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4{-}4 \\ \qquad\quad H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2\,H_2 \end{array}$$

The carbon has 60 units left unemployed, which can take up subordinates, consequently, two of hydroxyl are required to complete the ruling number of 64.

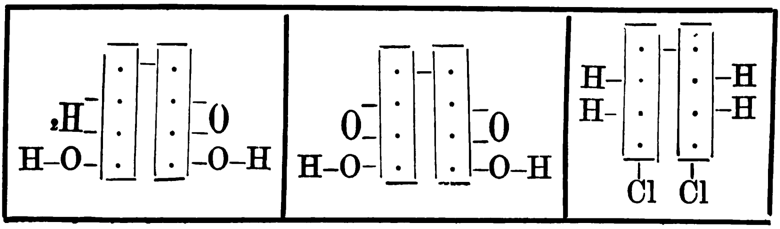
The mode of the modification will now be shown in the first number of the series, and will serve as a general type of the modification.

In Ethylene C_2H_4, the position of the carbon-atoms, is like that of two books placed side by side, the edges of which, facing the reader, would represent the face of the compound. Or,—from the difficulty of depicting the descriptive formula on one plane—if we imagine the following formula to be like the two leaves of an open book, then, if we close the book, the edges will represent the face of the compound.

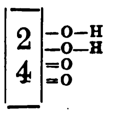
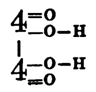
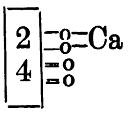
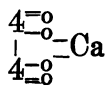
C_2H_4 $\qquad$ C_2H_4O $\qquad$ $C_2H_6O_2$ $\qquad$ $C_2H_2O_2$



$C_2 O_3 H_4$ $C_2 O_4 H_2$ $C_2 H_4 Cl_2$



The two atoms of carbon, forming the face of the compounds in this series, are an artificial imitation of the face of the elementry sulphur-atom, with the exception,—as just explained—of a different arrangement in, and of the groups. The mode of action, and the numerical law of Oxalic Acid, being analogous to that of Sulphuric Acid. Ruling number 16.

	$S O_4 H_2$	$C_2 O_4 H_2$		$S O_4 Ca$	$C_2 O_4 Ca$
Acids.			Salts.		
	16	16		16	16

The carbon numbers having two deducted from them, (which are used between the atoms of the carbon), as already explained in the law of immediate-relationship, at page 16. The numerical law, in this instance, being a minor subordinate law of the series.

This series, as has been shown in the hydrogen diagram, at page 61, forming a double chain, the carbon-atoms and their attendant hydrogen being gathered, step by step, in a similar manner to the sulphur in the sulphide series.

The Glycol, Glycollic Acid, and Oxalic-Acid, being analogous to a combined double Methyl-Alcohol, the Methyl-Alcohol and a double Formic-Acid, each combination having two atoms of hydrogen less than in the separate orignal compounds.

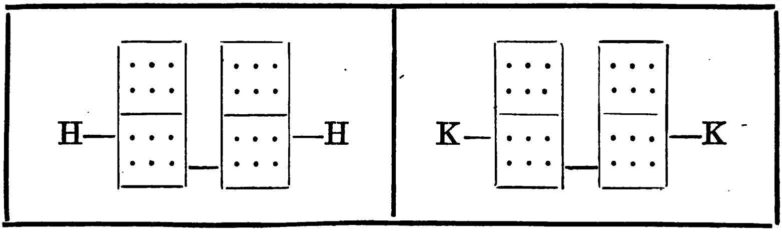
SECOND
HYDROGEN MODIFICATION.

(1st STAGE.)

Acetylene, $C_2\,H_2$

In this modification, four units are *latent.* The constituent-units in the Carbon, upon the faces of the compounds, having only partly formed their divisions, thus—

$C_2\,H_2$ Replaced by K_2



SERIES. (Carbide.)

$$H\overset{\sqsubset}{—}4\text{———————}C_{13}\,H_{26}\text{———————}4\overset{\sqsupset}{—}H$$

32.

28 subordinates, and 4 units latent.

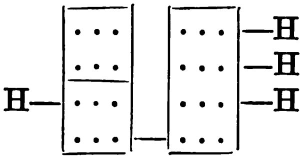
SECOND MODIFICATION.

Continued.

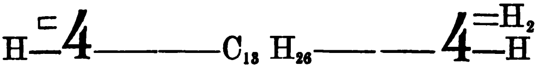
(2nd STAGE.)

In this series, two units remain *latent* upon the face of the first carbon atom, while the others open out,

thus—



SERIES. (Carbide.)

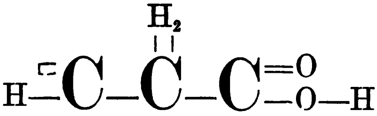


$$H\overset{\sqsubset}{-}4 \text{———} C_{18}\,H_{26} \text{———} 4\begin{matrix}=H_2\\-H\end{matrix}$$

32.

30 subordinates, and two units latent.

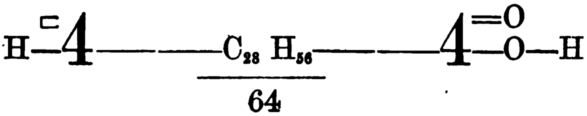
But the acids begin to form only upon the third Carbon-atom; because, two units being latent, that amount of Hydrogen is deficient, this is made good in the Hydrogen of the second Carbon-atom, thus, Acrylic acid $C_3\,O_2\,H_4$



$$H\overset{\sqsubset}{-}C-\overset{\overset{H_2}{||}}{C}-C\begin{matrix}=O\\-O-H\end{matrix}$$

The amount of subordinates are now precisely the same as in Acetic acid, the formation of the acids being deferred, consequently, there will only be 28 acids in this series.

The highest member (not known at present), is given.



$$\mathrm{H}-\overset{\sqsubset}{4}\text{———}\underset{64}{\underline{\mathrm{C}_{28}\ \mathrm{H}_{56}}}\text{———}4\begin{array}{l}=\mathrm{O}\\-\mathrm{O}-\mathrm{H}\end{array}$$

62 subordinates, and two units latent.

A more elaborate work upon the Carbon-compounds, Modifications, Derivatives, the Principles of Group Formation, &c., is in course of preparation.

It has ever been the proud boast of Man, that he alone, of all animated nature, possesses the faculties necessary to understand, and appreciate the science of numbers. That peculiar power to add, multiply, and divide, which enables him to measure, weigh, compare, and estimate quantities, and which forms the real basis of his reasoning-powers and intelligence.

Yet we have in Chemical union—as has been demonstrated in the preceding pages—minute physical points of matter, acting totally independent of the great law:—"Every particle of matter in the universe attracts every other particle, with a force directly proportioned to the mass of the attracting particle, and inversely to the square of the distance between them." The atoms, when placed under the necessary conditions, moving spontaneously to their union, uninfluenced by relative mass or weight, and only in strict obedience to certain numerical principles. The problem of Chemical combination resolving itself into harmonious sequences of symmetrical numbers!

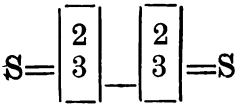
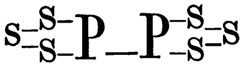
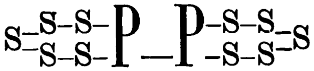
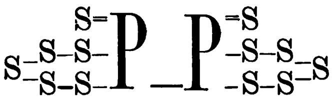
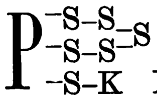
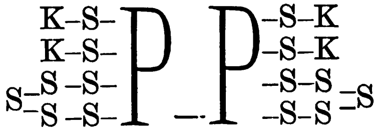
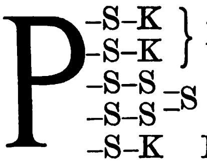
The numerical equations advanced in the preceding pages, are the pictorial explanations of the present well-established facts of chemistry, and, in the various classes of salts, cover the formation of thousands of chemical compounds. Nor will it lessen or diminish our admiration and wonder, although we now know the producing cause of the phenomena; for we can now truly *begin* to understand the beautiful simplicity, and yet the intricate complexity—the unity, and yet the infinite variety—the magnificence, comprehensiveness, and entirety, of the plan of Chemical combination.

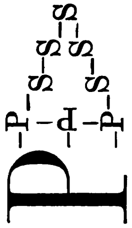
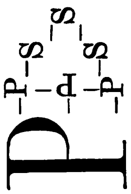
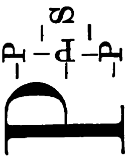
The next part of this Generalization, will contain the Governing principles of the variable element Nitrogen; its Monad-Relations, Oxides, Acids, and Organic Principles. Oxygen, Exposition of its Combining Properties, Hydrates of Compounds, Water of Crystallization, &c.; Boron, Fluorine, and the Metals of the Alkalies, Potassium, Sodium, &c.

To conclude this part, I will give a diagram of a class of compounds that has been very little studied as yet, namely, the Sulphur Compounds of the two Hydrogen modifications of Phosphorus (see page 24).

These compounds are not only remarkable for their mode of combination, but also for the immense store of energy lying latent in them.

FIRST AND SECOND MODIFICATIONS
OF THE
PHOSPHIDES OF SULPHUR.

P_2S_2	
P_2S_6	
P_2S_{10}	
P_2S_{12}	
	Not known, but probable salts (with the S_2K_2 series of Sulphides.)
PS_6K	 Monobasic.
$P_2S_{14}K_4$	 Tetrabasic.
PS_8K_3	 Dibasic. Monobasic.
	(Similar to the oxy-phosphites.)

P_4S_5	
P_4S_3	
P_4S	

For the Primary Phosphides, see page 42.

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